

**NOAA**  
**FISHERIES**

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**PAPAHĀNAUMOKUĀKEA**  
Marine National Monument & World Heritage Site



Since 1996, NOAA Fisheries and multiple agency partners have conducted surveys and removal of marine debris in the Northwestern Hawaiian Islands on a nearly annual basis. In the 17 years since these efforts began, nearly **769 metric tons (1.7 million lb)** of primarily derelict fishing gear have been removed from the shallow reefs and shorelines.

## MARINE DEBRIS

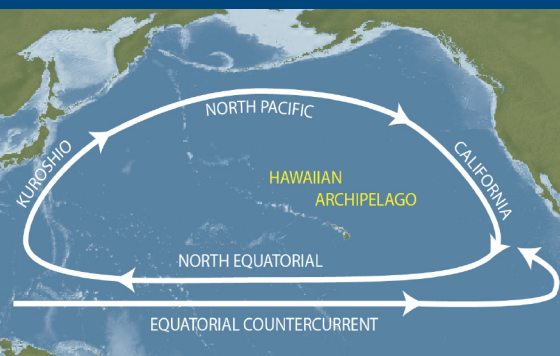
### REMOVAL AND ASSESSMENT AT MIDWAY ATOLL



A diver works to remove a large derelict fishing net on the backreef of Midway Atoll.

### THE NORTHWESTERN HAWAIIAN ISLANDS

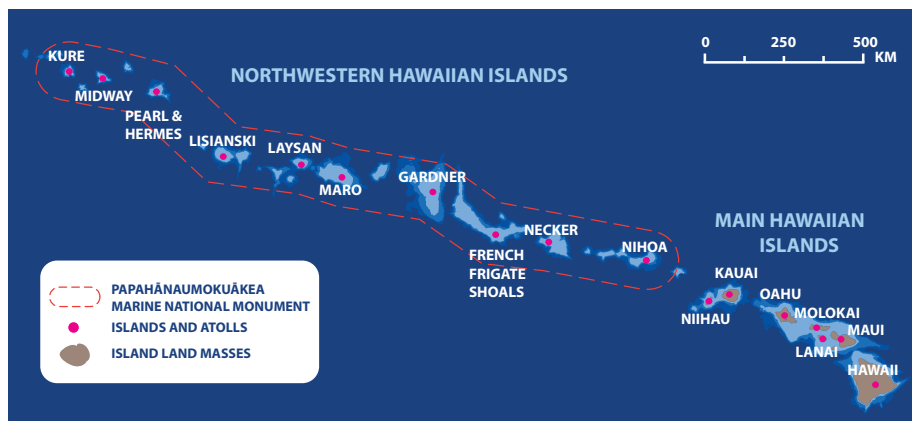
Stretching for 1900 km northwest of the eight main Hawaiian Islands is a chain of mostly uninhabited islands and atolls collectively known as the Northwestern Hawaiian Islands (NWHI). This unique area encompasses 362,073 km<sup>2</sup> (139,797 mi<sup>2</sup>) of the North Pacific Ocean and was designated the Papahānaumokuākea Marine National Monument (PMNM) in 2006 and a World Heritage Site in 2010. Inside the boundaries of the PMNM are reefs, atolls, and shallow and deep-sea habitats, including ~ 70% of all tropical, shallow-water (< 200 m) coral reef habitat in the United States (Executive Order 13178). The extensive coral reefs found in the PMNM are home to more than 7000 marine species, one quarter of which are found only in the Hawaiian Archipelago. The relatively small emergent land areas of these islands, a combined 15 km<sup>2</sup>, provide breeding and nesting habitat for 14 million seabirds representing 22 species, including four species found nowhere else in the world.



## North Pacific Gyre

The Papahānaumokuākea Marine National Monument (PMNM) is particularly prone to marine debris accumulation because of its central location in the North Pacific Gyre, a clockwise circular pattern of the prevailing ocean currents in which debris from around the North Pacific Rim circulates (*above*). Marine debris, especially derelict fishing gear, presents a potentially lethal hazard of entanglement to numerous marine species that reside in the PMNM, most notably the Hawaiian monk seal (*Monachus schauinslandi*), which is listed as endangered under the U.S. Endangered Species Act, the threatened green sea turtle (*Chelonia mydas*), and the endangered humpback whale (*Megaptera novaeangliae*).

Other plastic debris, found on shorelines and drifting in the pelagic environment, poses an ingestion threat to numerous seabird species, most notably the Laysan Albatross (*Phoebastria immutabilis*). Other potential effects of marine debris include habitat degradation in coral reef ecosystems, introduction of non-native species, and creation of potential hazards to boat navigation. The negative effects of derelict fishing gear and plastics on coral reef and island ecosystems are evident across the Hawaiian Archipelago, especially in the PMNM.



## ANNUAL SURVEYS

From 1996 to 2005, the marine debris team of the NOAA Pacific Islands Fisheries Science Center's Coral Reef Ecosystem Division (CRED) focused on mitigating decades of unchecked accumulation of derelict fishing gear (DFG) through large-scale survey and clean-up efforts across the entirety of the shallow reef environments of the NWHI. In 2006, operations were scaled back to a "maintenance mode" level aimed at keeping pace with new accumulation by resurveying areas historically shown to have high densities of DFG. Derelict fishing gear continues to accumulate at an estimated 52 metric tons per year in the NWHI (Dameron et al. 2007).

## 2013 MISSION

From March 28 to April 18, 2013, CRED's nine-member team of specialists conducted a 21-day operation for the survey and removal of marine debris at Midway Atoll. This mission was conducted with the assistance of partners from the U.S. Fish and Wildlife Service's Midway Atoll National Wildlife Refuge. They provided invaluable infrastructure support for this shore-based operation. Historically, the focus of marine-debris-related efforts in the NWHI has been the removal of DFG from shallow reef and shoreline environments. In 2013, however, the scope was broadened to include various scientific objectives, in particular, the establishment of a study of debris accumulation rates at Midway Atoll.

A Laysan Albatross chick is freed from entanglement in a derelict fishing net on Eastern Island.







## SURVEY AND REMOVAL

In 2013, survey and removal of marine debris at Midway Atoll remained the primary objective of operations. However, those efforts were successfully tailored to accommodate the sampling design for an accumulation study developed by Marine Debris Project staff. There were two components to survey and removal work: in-water survey and removal of DFG from Midway's barrier reef, and shoreline survey and removal of DFG and plastics from the beaches of all three of Midway's islands (Sand Island, Spit Island, and Eastern Island). Over the course of 18 operational days at Midway Atoll, the Marine Debris Project team successfully removed **13 metric tons (28,715 lb)** of DFG and plastics from the environment.



### In-water component

In-water surveys were conducted within preselected regions of the backreef at Midway Atoll in depths of 0–9 m. Towed divers and 5-m inflatable boats were used to survey and remove any DFG found snagged on the reef. From a backreef area of 2.86 km<sup>2</sup>, the team removed **44 individual net clusters** that weighed more than 2 metric tons (2271 kg) combined.

### Shoreline component

All plastic items with a longest dimension > 10 cm were removed from pre-selected shoreline areas at the three islands of Midway Atoll. In addition, bottle caps and cigarette lighters, which were < 10 cm, were removed to mitigate the ingestion hazard they posed to seabirds. All metal, wood, and nonplastic debris was left in place, regardless of size. Notably large debris items that were left in place were tagged for identification in future efforts.

A slightly modified version of the standardized shoreline-survey data-sheet from the NOAA Marine Debris Program was used to count different types of debris during the removal process.



**30,492**  
hard plastic  
fragments



**5705**  
oyster  
aquaculture  
spacers



**4781**  
bottle caps



**2214**  
beverage  
bottles



**980**  
toothbrushes  
and personal  
care items



**886**  
slippers  
(flip-flops)

From a survey area of 0.28 km<sup>2</sup> along the shorelines of Midway Atoll, the team removed **58,251 individual pieces** of debris that weighed nearly 12 metric tons (11,524 kg) combined.

*Above left:* The Marine Debris Project team secures a load of plastic debris for removal. *Below left:* Some of the 117 plastic baskets removed from the surveyed areas of Midway Atoll's shoreline.

## Standing-stock surveys

As part of a nationwide effort by the NOAA Marine Debris Program to compare debris sources, amounts, locations, movement, and effects of marine debris, a set of standardized shoreline surveys has been developed. These surveys are conducted by scientists, nonprofit organizations, and other environmental agencies. To add debris information representing Midway Atoll to the database for this national effort, CRED's 2013 marine debris mission included one NOAA Marine Debris Program standing-stock survey conducted on the northern shore of each island within three pre-selected 100-m transects. These surveys, which involve tallying shoreline debris types and sizes, were done in such a way that it did not compromise the data collected for CRED's data set.

## ACCUMULATION STUDY

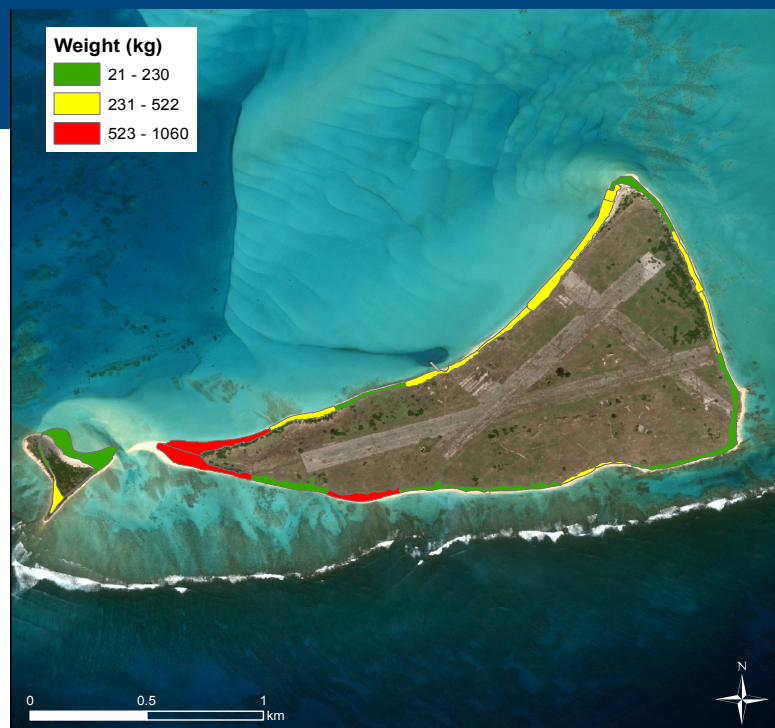
This year, the Marine Debris Project team began an opportunistic pilot study to aid in the quantification of marine debris accumulation at Midway Atoll. This study was made possible by a previous CRED marine debris removal effort conducted in June 2012, which resulted in a complete survey of and removal of DFG and plastics from all surveyable backreef and shoreline areas at Midway Atoll. This “clean sweep” of surveyable areas represented a zero baseline for measuring accumulation of debris during subsequent survey efforts. Therefore, the work in April 2013 revealed the amount of debris that had accumulated during the 279-day (~ 10-month) period since the baseline was established in 2012.

### In-water component

To assess in-water accumulation, the backreef area that was surveyed in 2012 was divided into 35 individual polygons, which were then grouped into five geographical zones (A, B, C, D, and E) on the basis of their directional aspect around the barrier reef (*below*). Using a stratified random sampling method across these five zones, 15 polygons were surveyed and more than 2 metric tons (2271 kg) of DFG were removed from them as a result. Given the total survey area of 2.86 km<sup>2</sup>, the average density of accumulated DFG within sampled polygons was calculated at 670.4 kg/km<sup>2</sup>. Complete accumulation results will be published at a later date.



Map of the in-water survey areas and locations of debris removal around Midway Atoll.



Map of shoreline surveys showing areas of debris accumulation around Eastern and Spit islands.

### Shoreline component

A similar approach was used for assessment of accumulation of shoreline debris. For each of the three islands of Midway Atoll, the shoreline area (from the vegetation line to the water's edge) that had been surveyed in 2012 was divided into 300-m linear segments. These segments were then grouped into three geographical zones per island on the basis of the directional aspect of the beach. A stratified random sampling method was used to select segments across these three zones for survey in 2013. Because of unexpected removal of marine debris by a volunteer group on Sand Island's shoreline just prior to the arrival of the CRED team, the focus of efforts shifted to survey a greater number of segments on Eastern Island and Spit Island than originally planned. This change resulted in the complete survey of the shorelines of both Eastern and Spit islands (*above*), allowing for the calculation of accumulation values on the basis of a complete census rather than on a sample of areas on those islands.

The 23 shoreline segments of Eastern and Spit islands were successfully surveyed and all DFG and plastics were removed. From the shorelines of both islands, 49,823 individual pieces of debris, weighing nearly 8 metric tons (7673 kg) were found to have accumulated during the ~ 10-month period between surveys. Given total shoreline survey areas of 0.14 km<sup>2</sup> and 0.02 km<sup>2</sup>, the average density of accumulated debris on the shorelines of Eastern and Spit islands was calculated to be 0.054 kg/m<sup>2</sup> and 0.045 kg/m<sup>2</sup>.





## Debris Related to the Japan Tsunami

A secondary objective of the 2013 mission was to survey Midway Atoll for possible debris related to the tsunami that struck Japan in March 2011. Any debris items suspected to be associated with the Japan tsunami were documented and reported to the Japan Tsunami Marine Debris Assessment and Response Framework Subject Matter Expert Group for the Northwestern Hawaiian Islands through the NOAA Marine Debris Program. Only two items found at Midway Atoll during this 2013 effort were confirmed to be related to the Japan tsunami.

A large, blue pallet tub of the type used to ship seafood and approximately 1.5 × 1.2 m in size was found during surveys on the southwestern tip of Sand Island (below left). Because of company information written on the side of this tub, the Consulate-General of Japan in Honolulu was able to make inquiries and confirm that this particular item was lost as a result of the tsunami.

Additionally, from the shoreline of Eastern Island, the team successfully removed a 7-m (23-ft) derelict Japanese fishing boat (above). This 770-kg boat was discovered by U.S. Fish and Wildlife Service personnel in November 2012 but left in place over the winter. By tracing the registration numbers on the bow of the boat, the Consulate-General of Japan was able to confirm that the vessel was lost in the tsunami. The weight of this boat contributed to the total 12 metric tons of debris removed during shoreline operations.





## Partners

Funding for these efforts was provided by the PMNM, NOAA Marine Debris Program, and NOAA Damage Assessment Remediation and Restoration Program. Additional support was provided by the U.S. Fish and Wildlife Service, the State of Hawai'i, our partners in the Hawai'i Nets to Energy Program, including Schnitzer Steel Hawai'i Corp., Covanta Energy, and the City and County of Honolulu, and many other partners who contribute to this effort and help make it a success each year.

## References

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Executive Order 13178. 3 C.F.R. 13178 (2001).

Opfer S, Arthur C, Lippiatt S. 2012. NOAA marine debris shoreline survey field guide, 14 p. U.S. Dep. Commer., NOAA National Ocean Service, Office of Response and Restoration Marine Debris Program, Silver Spring, MD. [Available from <http://marinedebris.noaa.gov>.]

All photos courtesy of NOAA.

*Above:* CRED Marine Debris Project team standing atop 13,795 kg of derelict fishing gear and plastics removed from Midway's back-reef and shoreline areas in 2013. (Disposable lighters comprise the "2013.")

*This document may be referenced as:* PIFSC. 2014. Marine Debris: removal and assessment at Midway Atoll 2013. NOAA Fisheries Pacific Islands Fisheries Science Center, PIFSC Special Publication, SP-14-001, 6 p.

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NATIONAL MONUMENT  
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[www.papahanaumokuakea.gov](http://www.papahanaumokuakea.gov)

**NOAA MARINE DEBRIS PROGRAM  
OFFICE OF RESPONSE AND RESTORATION**  
<http://marinedebris.noaa.gov>

**CORAL REEF ECOSYSTEM DIVISION  
PACIFIC ISLANDS FISHERIES SCIENCE CENTER**  
[www.pifsc.noaa.gov/cred/marine\\_debris.php](http://www.pifsc.noaa.gov/cred/marine_debris.php)

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